

**HYDRAULIC CONDUCTIVITY STUDY IN
ENGINEERED SOIL MEDIA FOR
STORMWATER RUNOFF TREATMENT IN
BIORETENTION FACILITY**

HUSNA BINTI TAKAIJUDIN

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**HYDRAULIC CONDUCTIVITY STUDY IN ENGINEERED SOIL
MEDIA FOR STORMWATER RUNOFF TREATMENT IN
BIORETENTION FACILITY**

by

HUSNA BINTI TAKAIJUDIN

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LIST OF SYMBOLS

| | |
|-----------|---|
| A | Contributing Drainage Area |
| A_c | Surface area of column |
| BD | Bulk density (g/cm^3) |
| C_c | Coefficient of Curvature |
| C_f | Target TSS concentration (mg/L) |
| C_{ini} | TSS concentration of raw stormwater runoff before dilution (mg/L) |
| C_u | Coefficient of Uniformity |
| C_v | Runoff Coefficient |
| D | Diameter of column |
| D_{10} | Grain size at 10% finer |
| D_{30} | Grain size at 30% finer |
| D_{50} | Grain size at 50% finer |
| D_{60} | Grain size at 60% finer |
| D_r | Relative density |
| G_s | Specific gravity |
| K_e | Total K_{sat} |
| K_{eff} | K_{sat} during the application of synthetic stormwater runoff |
| K_{ini} | K_{sat} during the application of clean water (tap water) |
| K_{rel} | Ration of K_{eff} over K_{ini} |
| K_{sat} | Saturated hydraulic conductivity (mm/hr) |
| L | Length of soil (m) |
| L_T | Total length of soil media |
| m | mass of soil material |

| | |
|-----------|----------------------------------|
| n | a number of samples |
| P | Ponding depth (m) |
| P_D | Rainfall depth (mm) |
| Q | Outflow rates |
| R^2 | Coefficient of Determination |
| V | Volume of soil materials |
| V_f | Working volume |
| V_{ini} | The volume required for dilution |

LIST OF ABBREVIATIONS

| | |
|------------------|--|
| AASHTO | American Association of State Highway and Transportation Officials |
| ANN | Artificial Neural Network |
| ANOVA | Analysis of Variance |
| APHA | American Public Health Association |
| ARI | Annual Recurrence Interval |
| BMPs | Best Management Practices |
| BOD ₅ | Five-day Biochemical Oxygen Demand (mg/L) |
| BOD _r | BOD removal |
| BSI | British Standard Institution |
| C | Compost |
| COD | Chemical Oxygen Demand (mg/L) |
| COD _r | COD removal |
| CS | Coarse Sand |
| Cu | Cuprum |
| CVF | Compost Fraction Volume |
| DID | Department of Irrigation and Drainage |
| DO | Dissolved Oxygen |
| DOE | Department of Environment |
| ESP | Exchangeable Sodium Percentage |
| ET | Evapotranspiration |
| FAWB | Facility of Advanced Water Biofiltration |
| FS | Fine sand |
| GLM | General Linear Model |

| | |
|---------------------------------|--|
| HRT | Hydraulic retention time |
| IWS | Internal Water Storage |
| LID | Low Impact Development |
| MLR | Multiple Regression Method |
| MS | Medium sand |
| MSMA | Manual Saliran Mesra Alam Malaysia |
| N | Nitrogen |
| NH ₃ | Ammonia |
| NH ₃ -N | Ammoniacal nitrogen |
| NH ₃ -N _r | NH ₃ -N removal |
| NH ₄ ⁺ | Ammonium |
| NO ₂ ⁻ | Nitrate |
| NO ₃ ⁻ | Nitrite |
| NO _x | Nitrogen gas |
| P | Phosphorus |
| Pb | Plumbum |
| PSD | Particle Size Distribution |
| REDAC | River Engineering and Urban Drainage Research Centre |
| PTF | Pedotransfer |
| RMSE | Root Mean Square Error |
| SAR | Sodium Absorption Ratio (SAR) |
| SCMs | Stormwater Control Measures |
| SD | Standard Deviation |
| SLR | Single Linear Regression |
| SUDs | Sustainable Urban Drainage system |

| | |
|------------------|---|
| TCOD | Total Chemical Oxygen Demand |
| TN | Total Nitrogen |
| TN _r | TN removal |
| TP | Total Phosphorus |
| TP _r | TP removal |
| TS | Topsoil |
| TSS | Total Suspended Solids |
| TSS _r | TSS removal |
| USCS | Unified Soil Classification System |
| USEPA | United States Environmental Protection Agency |
| WQI | Water Quality Index |
| WQ _v | Water Quality Volume (m ³) |
| WSUD | Water Sensitive Urban Drainage |
| Zn | Zinc |

**KAJIAN KEBERALIRAN HIDRAULIK MEDIA TANAH KEJURUTERAAN
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BIOPENYIMPANAN**

ABSTRAK

Kaedah konvensional sistem perparitan seolah-olah tidak mencukupi untuk memenuhi air larian permukaan bandar akibat peningkatan populasi bandar yang mendadak. Ia adalah terhad kepada pendekatan struktur yang berkaitan dengan pengaruh hidraulik dan hidrologi. Oleh itu, pendekatan ini telah beralih kepada pendekatan yang lebih holistik dengan mengambil kira keperluan alam sekitar. Pindaan garis panduan Manual Saliran Mesra Alam Malaysia (MSMA) pada tahun 2012 telah diperkenalkan pada bersesuaian dengan amalan semasa untuk menangani isu-isu air ribut bandar dan sub-bandar. Biopenyimpanan adalah amalan yang digalakkan yang menerapkan proses semula jadi, mengintegrasikan pengetahuan sains dan kejuruteraan hidrologi, hidraulik dan alam sekitar ke dalam satu sistem. Kajian ini bertujuan untuk menyelidik interaksi antara parameter hidraulik tanah terutamanya keberaliran hidraulik tepu (K_{sat}) dan prestasi olahan kualiti air dan penentuan K_{sat} sebagai penanda aras berdasarkan prestasi biopenyimpanan. Set data komprehensif yang diperlukan untuk kajian ini telah diperolehi daripada beberapa siri ujian makmal standard, kajian kolum yang direkabentuk dan penyiasatan lapangan. Bagi tujuan ini, tiga (3) kolum tanah telah dibina di Makmal Permodelan Fizikal, Pusat Penyelidikan Kejuruteraan Sungai dan Saliran Bandar (REDAC), USM. Empat (4) konfigurasi tanah dan satu (1) parameter hidrologi telah diuji untuk kajian ruang tanah: campuran tanah kejuruteraan, kedalaman media, bahan-bahan kompos, lapisan sungkupan dan variasi aliran masuk.